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**ABSTRACT**

Three graphics producers were interviewed in order to explore the costs associated with production of microfiche, as opposed to the plasma panel, so that an informed selection could be made in those cases in which either technique would suffice. The three producers disagreed about the best production techniques to use, as well as how long various production related tasks might take. For example, substantially different techniques were used to create plasma displays. However, all three graphics producers agreed that freehand drawing on the plasma panel is not an efficient technique. Tables are included showing comparative costs for each graphics producer. (Author/STS)

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# A COMPARISON OF THE COSTS FOR ILLUSTRATIONS PRESENTED BY THE PLASMA PANEL AND MICROFICHE

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### Introduction

The facilities of the microfiche projector and the plasma panel overlap somewhat. Each has its unique capabilities and constraints, but in many cases either can be used. Some authors and site directors consistently choose fiche over plasma displays, or vice-versa, because they are convinced one is considerably less expensive. However, to the best of our knowledge, no cost comparisons have been published. This study was undertaken to explore the costs associated with each display technique for those cases where either suffices.

This report was designed to be non-comprehensive in scope. Therefore, it is necessary to put disclaimers on the interpretation of the findings contained herein. Though they were carefully selected, only three graphics producers were interviewed. All were perceived by MTC and their colleagues to be dedicated, hard-working professionals, possessing substantial experience with both the PLATO system and visual media. Their experiences provided them with optimized techniques as well as firm convictions about "best" ways of performing certain tasks. Nevertheless, they disagreed considerably about what these "best" methods were, and how long various tasks might take. Unfortunately, these differences could not be resolved by gathering the graphics producers into a room for a conference. All were geographically separated; one was no longer working on the PLATO system when she was interviewed. Therefore, the reader is cautioned to weigh carefully any conclusions drawn from this data.

The disparities in the data suggest that further investigation might reduce the time and costs for producing PLATO visuals. In addition to providing preliminary data, we hope this report encourages users to record and exchange data on production costs and time.

### Background

Most of the information was gathered from two full-time professionals. One, a medical illustrator working at Sheppard Air Force Base, had two years PLATO experience when he made the estimates given in this report. Another was a long-time CERL staff member who designed and coordinated graphics for the elementary reading curriculum development program.<sup>1</sup> Other data were supplied from a "non-artistic" Chanute author who had prepared a sizeable number of the visuals at that site and who had gained high facility with using the graphic editors available on the PLATO system. The Chanute staff member who produced graphics has a B.S. in mathematics and was one of the best and most proficient programmers at that site. She worked at Chanute for 1½ years. Her estimates of the time needed to produce graphics was based on experience gained through August, 1975.

### Experience

The Sheppard medical illustrator and the Reading Group designer have the resources to produce either paper drawings, for conversion to fiche, or plasma drawings. The Chanute author typically had to choose between finding a drawing in a manual or text for conversion to fiche, or using a plasma drawing (that is, there was no illustrator or artistically-skilled author available to do original work).

Sheppard. The Sheppard medical illustrator divided his line drawings into two categories: schematics and illustrations. His schematic drawings

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<sup>1</sup>The Elementary Reading Project was funded by the National Science Foundation, contract no. USNSF C-723.

are stylized and simplified so that exact proportion and positioning are not critical. An illustration, however, must have exact proportion and positioning, especially in this illustrator's field, medicine. Since the PLATO system allows animations of plasma drawings (though not for fiche images), the illustrator also included an additional increment of time for that. He estimated his production time as shown in Table 1.

Table 1  
Sheppard Illustrator's Time Estimates

|            | <u>Schematics</u> | <u>Illustrations</u> |
|------------|-------------------|----------------------|
| fiche      | 40 min.           | 5.5 hours            |
| plasma     | 15-60 min.        | 90-180 min.          |
| +animation | 40 min.           | 3 hours              |

His estimates were not based on any sort of log, but were averages about which he felt confident. Further, because MTC perceived him to have great artistic ability and a comparatively difficult subject, his estimates may not be reproducible at other sites. Nevertheless, his relative estimates for different types of production should be generalizable.

The Sheppard illustrator prepares line drawings for plasma presentation by sketching first on clear acetate, then physically superimposing his sketch over the plasma panel and tracing in "SD" mode. He feels this technique saves at least half the time he would spend if he worked from paper.

For large drawings made from 8x16 dot characters, he uses the special character editor directly, again without resorting to paper. A large

drawing requiring 20-25 characters takes from 30 to 60 minutes, with another 30 minutes needed for animations. Because the data for drawings formed from characters corresponds closely to the data for schematic drawings, no separate entry was made in Table 1.

#### Chanute

The Chanute author claims no artistic ability. For her to produce a plasma drawing, the author needing her services must find a drawing or picture (from the proper perspective) of what he wants. Using grids, she then makes a copy of the drawing to proper scale and adds the animation or highlights the details the author wishes. A simple drawing takes her four hours, while a complex graphic with animation may take as long as 80 hours. She has no estimate about how long it takes the authors she works with to find the drawing for her to copy, but feels that half an hour is not an overestimate.

#### Reading Group

The designer-coordinator for the Reading Group uses the services of an illustrator in every case. The illustrator prepares a rough drawing (.5 hours) which is reviewed by the coordinator and revised by the illustrator (.5 hours). If it is to be drawn from characters, it is then converted to dots on a paper grid, corrected, and entered by the coordinator into the computer. Any final corrections complete the task. If the sketch is to be converted to a line drawing, a grid is placed over the sketch. Aided by the grid, the coordinator transfers the drawing to the computer.

The illustrator's final product (to be converted into a plasma drawing) could be photographed for conversion to microfiche without additional

labor by the illustrator. Therefore, the illustrator's time was used in Table 2 as the time needed to prepare illustration for conversion to fiche. His estimate agrees roughly with that of the Sheppard illustrator (40 minutes versus 60 minutes). The main difference between the time estimates for creating plasma drawings arises from creating the drawing on the computer. For the Reading group, this takes from 1.5 to 4 hours depending on complexity. The coordinator's rough estimates are listed in Table 2.

Table 2

Time Estimates — Reading Group Coordinator

|                                              | <u>Time Needed</u> |
|----------------------------------------------|--------------------|
| Fiche                                        | 1 hour             |
| Plasma (line drawing or 20-25 char. drawing) | 2.5-5 hours        |

Aberdeen

The Aberdeen final report contains cost estimates for the entire production process for a 35mm slide (art work, photography, development and mounting). Unfortunately, the information in the report is self-contradictory. Apparently, either a cost of \$25 or \$100 per 35mm slide (for sound-on-slide use) was estimated.

### Fiche Production Costs

The illustrator's time is not the only cost incurred in producing fiche. The drawings must be photographed, developed, mounted, sent to CERL to be made into a fiche, and returned to the (remote) site. The delays and costs occurring during this process are estimated in this section.

### Chargeable Costs

The typical fiche submitted by ARPA users during 1975 contained an average of slightly fewer than 100 images out of 256 possible. If the sites were billed for these fiche at the rate currently charged other educational users,<sup>2</sup> the price for 20 production fiche (i.e., enough finished quality fiche for a class) would average about \$150. This figure is lower than the actual cost of producing the fiche, but is felt to be a realistic cost once the sizeable set-up charges are amortized and the production has increased. It was purposely set lower than actual costs to avoid a "chicken-and-egg" problem. (Because of fixed expenses and low initial demand for fiche, initial costs would have been so high as to discourage increasing use. Thus, a high-volume, low-cost situation could never be reached).

The cost for preparing 35mm images is difficult to pinpoint precisely. The CERL microfiche/photography staff estimates the cost for preparing slides from drawings at \$100 to \$200 per 100 images, based on time and costs accrued while working with the CERL Elementary Reading Group. A

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<sup>2</sup>The ARPA contract pays for these costs in the aggregate, rather than on a fiche-by-fiche basis.

University of Illinois graphics service charged CERL about \$4/image for photographing drawings and actual engine components at Chanute: \$2250 for 500-600 35mm slides.<sup>3</sup> We considered that this amount was excessive (especially considering the quality of the product) and hence the figure should perhaps be viewed as the top of the cost range. Thus, an estimated range of \$1 to \$4 per image (based on a run of 100) reflects differences in (a) the difficulty of handling the originals because of variations in size, positioning, etc., (b) local price variations and (c) the quality of the product.

#### Time Delay Costs

At Sheppard, it took about three weeks to photograph, develop, and mount the 35mm images. Typically, another two weeks expired before a trial fiche (i.e., not a production run of multiple copies) returned from CERL. Assuming only exposure corrections were needed and no slides had to be re-shot, a group of 20 finished fiche could be delivered to the site two weeks later (seven weeks after the illustrations had been completed). Chanute developed its own fiche much of the time. Though some delays were reduced, few sites have attempted to do their own processing. Eventually, Chanute reverted to CERL processing in order to attain acceptable quality. On-campus users can, of course, avoid many of the delays of shipping (typically, one week one-way to Sheppard Air Force Base in Texas). Ordinarily, the extra time delays for fiche production do not increase

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<sup>3</sup>The Sheppard AFB photolab costs are heavily subsidized: thus actual costs are unknown. The billed charge to the Sheppard project was \$0.03 slide.

the costs nor cause much inconvenience (if lesson planning is coordinated); thus the extra time needed for the production of fiche is not reflected in the cost analyses below.

Delays are also common when "outsiders" request copies of a fiche. Either a copy must be borrowed from the creators or the 35mm images must be re-photographed. In some cases, the slides may still be at CERL; in other cases the author must ship them to CERL to have the copy made. A total delay of a month is common if one of the parties involved is at a remote site.

### Comparison of Estimated Costs

#### Assumptions for Cost Comparison

The cost comparison that follows requires several assumptions. The cost of training and setting up the facilities for production of graphics is ignored. The \$10 per hour labor cost is based on assumed direct salary costs of about \$10,000 per year with indirect costs (light, heat, office space) and equipment doubling the total expenditure. No consumable supplies and no computer time were included. Training costs were also ignored. Though training an illustrator to make plasma drawings surely takes longer than training an illustrator to prepare paper drawings for 35mm photography, we have no estimates about the training needed for either medium.

The comparison figures assume a need for 20 copies of a fiche containing 100 images. Non-ARPA users typically include more images per fiche, and based on the current CERL microfiche preparation price schedule, they thereby reduce the "per image" cost of making a fiche. The setup charge for fiche is not large compared to the cost for copies. For 100 images, the first fiche costs \$21.28, copies are \$6.76.

The economics of the distribution of images is mixed: plasma drawings are instantly available without payment to even casual users who access a lesson, but they exact a "charge" for the extra ECS memory required. Fiche images require preplanning and prepayment in order to be available when needed, but are free from recurring ECS costs. Since the cost estimates range widely, it is difficult to compute "break even" points in terms of the number of copies of a fiche required to match the cost of plasma drawings, assuming no ECS "cost." Modifications to system

architecture may eventually make the extra ECS charge for plasma drawings irrelevant.

### Cost Comparison

Based on the above estimates of the graphics producers and the assumption that direct and indirect salary costs average \$10 per hour, costs can be estimated as in Tables 3 through 6.

Table 3

#### Sheppard Cost Data (professional illustrator)

| <u>Microfiche for Schematics</u>                | <u>Cost</u>             |
|-------------------------------------------------|-------------------------|
| .67 hour/drawing × 100 drawings × \$10/hour     | \$667                   |
| (\$1 to \$4/slide) × 100 slides                 | \$100 to \$400          |
| 1 master + 20 copies of fiche                   | \$150                   |
| Total cost for 20 usable fiche                  | <u>\$900 to \$1200</u>  |
| <br><u>Plasma for Schematics</u>                |                         |
| (.25 hour to 1 hour) × 100 drawings × \$10/hour | <u>\$250 to \$1000</u>  |
| <br><u>Microfiche for Illustrations</u>         |                         |
| 5.5 hour/drawing × 100 drawings × \$10/hour     | \$5500                  |
| (\$1 to \$4/slide) × 100 slides                 | \$100 to \$400          |
| 1 master + 20 copies of fiche                   | \$150                   |
| Total cost for 20 usable fiche                  | \$5750 to \$6050        |
| <br><u>Plasma for Illustrations</u>             |                         |
| (1.5 hour to 3 hour) × 100 drawings × \$10/hour | <u>\$1500 to \$3000</u> |

Table 4Reading Group Data (experienced designer/coordinator)

| <u>Microfiche</u>                         | <u>Cost</u>             |
|-------------------------------------------|-------------------------|
| 1 hour/drawing × 100 drawings × \$10/hour | \$1000                  |
| (\$1 to \$4/slide) × 100 slides           | \$100 to \$400          |
| 1 master + 20 copies of fiche             | \$150                   |
| Total cost for 20 usable fiche            | <u>\$1250 to \$1550</u> |

Plasma

|                                                          |                         |
|----------------------------------------------------------|-------------------------|
| 1 hour drawing/sketch × 100 sketches × \$10/hour         | \$1000                  |
| (1.5 to 4 hour coding/sketch) × 100 sketches × \$10/hour | \$1500 to \$4000        |
| Total cost                                               | <u>\$2500 to \$5000</u> |

Note. Cost data were gathered in 1975 and 1976.

Table 5Chanute Cost Data (talented author)

The figure of (4.5 to 80) hours/drawing indicates higher costs than either of those given above. A comparable cost for fiche produced at Chanute cannot be estimated. In fact, the 4.5 to 80 hour figure cited by the Chanute author certainly includes graphics which could not easily be duplicated with fiche. Hence the data is not strictly comparable with the data from other sites above.

Table 6Summary of Comparative Cost Data

| <u>Site</u> | <u>Plasma Costs</u> | <u>Fiche Costs</u> |
|-------------|---------------------|--------------------|
| Sheppard    | \$250-1000          | \$900-1200         |
| Chanute     | \$4500-80000 [sic]  | not available      |
| Reading     | \$2500-5000         | \$1250-1550        |

Other Costs

In addition to the time estimated in Tables 3 through 6. author-illustrator consulting time must be added to both fiche and plasma estimates; the illustrator from Sheppard spends about one-half hour with the author clarifying exactly the purpose of each drawing. The Chanute author also performed this activity, but did not estimate its length.

This consulting is a very important step because each drawing has "objectives" which must be communicated to the illustrator. For example, depending on the objectives or intended use of a drawing of an auto battery, the battery could be drawn only crudely or in great detail, with a "background" showing its position or isolated in space, from the side or from the top, with electrical cables attached or without. The importance of each of the details must be clear to the illustrator. For this reason (and based on comments from the Chanute author), attempting to replace an illustrator by maintaining a library of texts, manuals or other sources of graphics may increase, or at least will not reliably decrease, the time and most needed to prepare visuals. Because this planning time was not easily estimated and because it seemed nearly independent of medium, it

was not included in the previous analysis. Display planning is a real cost, however. It takes the time of at least two people, illustrator and author, and may nearly double some of the cost figures presented above.

### Conclusions

The basis for the lack of consensus about costs for producing graphics on fiche versus on the plasma panel is easier to understand after viewing the data in Tables 3 through 6.

### Summary

Sheppard Air Force Base. Based on this data, plasma drawings have a consistent dollar cost saving over fiche. However, systematic errors in the illustrator's estimates, improvements to the production techniques in one of the methods or changes in computer hardware could shift the balance. Indeed, the Sheppard estimate for plasma drawing time was revised downward between Fall 1975 and Spring 1976 based on changes to the "SD" feature. The These changes reduced the time needed to prepare plasma drawings to half its original value and thus reversed the choice of "cheaper medium." Though the data from the coordinator of the reading graphics was based on the old SD, a smaller fraction of her time overall was devoted to entering information into the computer; hence her time savings for the new SD could not have been nearly as large as those for the Sheppard illustrator. The Chanute author resigned her position before the new SD became available.

Elementary Reading Group. Based on the Elementary Reading group data, plasma drawings are about three times as expensive as fiche. The reason for the difference between this estimate and Sheppard's has not been determined. Based on interviews with the individuals noted here as well as with other ARPA authors, we conclude that even such a large discrepancy could be the result of unverified estimates and differences in task. More likely, however, it reflects the additional steps and staff involved in

the Reading group's production process. There are, of course, many other confounding factors as well.

Chanute Air Force Base. The Chanute data, though not available in a form that permits fiche versus plasma comparisons, suggests that the on-site illustrators can probably save time and money for a moderate sized (6 to 10 authors) curriculum development.

#### Limits of this Study

One conclusion that could be drawn from this report is NOT warranted: that Sheppard has the most efficient system and Chanute, the most costly. There are too many differences in the size, organization, and purposes of the projects examined for such a comparison to be valid. Moreover, at each site, staff used substantially different production techniques to create plasma displays. It should be noted that the main point that all three graphics producers agreed upon was that "free-hand" drawing on the plasma panel is NOT an efficient technique. On the other hand, the "free-hand" method is used by virtually every "lone" author and by most small authoring groups the MTC and PEER staffs know.

#### Further Study

One of the most surprising discoveries reached by readers of drafts of this report was the very large effort required to produce graphics of any kind for PLATO lessons. Attempts to take cost-saving shortcuts have generally not proved successful.<sup>4</sup> As noted in the previous paragraph, most

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<sup>4</sup>Larry Francis, PLATO IV Terminal Peripheral Devices (Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1976).

illustrations are currently being prepared by techniques which the three graphics producers felt were inefficient. This seems like a worthwhile subject to be studied. Testable hypotheses can be formulated and such a study might pay for itself quite readily in terms of the man-hours saved. Furthermore, additional data should be gathered from other graphics producers, preferably by performing standardized tasks and logging time.